Of the cases of rabies in human beings, three were true failures of the Pasteur treatment, all being severely bitten, two near the central nervous system. Eliminating all persons treated who were not bitten, the percentage of failures with virus supplied by this Bureau was .491, less than ½ of 1 per cent. These statistics are extremely important and unique because of the fact that in over 98% of the persons bitten, the animals doing the biting were checked by laboratory examinations, with positive results.

There were few ill effects following the Pasteur treatment during the period under consideration. In one case treated at this Bureau, some weeks after treatment there was a peculiar twitching of the muscles of the right side of the neck. In another patient 11 days following the completion of the treatment there was severe pains in the left eye, later affecting the side of the face. This was present at intervals for about a week. In one of the cases there was vomiting. This occurred every day for a short period of time and stopped after the completion of the Pasteur treatment. In another patient the local reactions that usually appear on certain days of the treatment from different strength virus occurred after each injection. In four instances subcutaneous abscesses developed. The only serious complication reported was a slight paralysis of the lower limbs, with prodromal symptoms of nausea and diarrhea, which occurred several days after the completion of the Pasteur treatment.

The large number of persons to whom the Pasteur treatment was administered, with the resulting low mortality, is sufficient evidence of its efficiency. Rabies being one of the easily eradicated infectious diseases, there should be no excuse for its presence in any community. The dog, as it has been aptly put, being the principal reservoir of the disease, eradication can be accomplished surely and expeditiously by rigid enforcement of muzzling plus a strict interstate quarantine of at least six months. In California, now that the disease is rampant in the coyote, there is urgent need of active state co-operation with the United States Biological Survey in their commendable campaign of destruction of the predatory animals.

DANGER OF BATHS IN PATIENTS SUFFERING FROM ARTERIO-SCLEROSIS.*

By DR. WILLIAM WATT KERR, San Francisco.

As the time of year is at hand when people are arranging to leave town for the summer months the following cases may be of interest to those physicians who are liable to be consulted by their patients regarding the propriety of visiting one or other of the many springs which abound in California. It not infrequently happens that too little attention is given to the fitness of individual cases to hydro-therapy, and consequently harm is done to the patient and also to the reputation of the particular spa which he chanced to select, so that others who would receive benefit are deterred by their friend's misfortune from availing themselves of the treatment. The popular idea that the surroundings at the various resorts are responsible for all improvement, and that although the baths may fail to relieve yet they never will do any harm, is extremely unfortunate. At least two things should be impressed upon those seeking advice: (1) that hydro-therapy is not adapted to all cases, (2) that the temperature and method of administration are of much greater importance than any salts contained in the water. This knowledge would prevent many. undesirable cases from going to the sanatoria, and might also bring to reason many of the guests who, in a desire to be thorough or "get their money's worth," drink too much of the water or indulge in too frequent or prolonged immersion. The cases mentioned tonight are only examples of one of the groups that require exclusion from the baths or very careful supervision during their administration; it is not always possible to tell from physical examination the condition of a man's arteries, because the peripheral vessels may be comparatively healthy while the coronaries and splanchnics are seriously diseased, and therefore in all patients after middle life the first baths should only be given in the presence of an expert medical attendant who is capable of estimating their influence upon the balance between cardiac strength and arterial resistance.

Case 1. A gentleman, aged 58, for nearly three years had been subject to radiating substernal pain that was readily induced by exertion, such as climbing seven or eight steps of a stair, especially if the exertion were undertaken soon after meals. Some time ago, while living at a summer resort where there were hot mineral springs, he commenced a series of baths, and it is only to the effect of these that I wish to call attention. The water came from the ground at a temperature of 140 Fahr., and contained a variety of salts, the most abundant being sodium carbonate, sodium bicarbonate, silica, and a trace of calcium. As I was spending part of my vacation at the same place I had an opportunity of observing him daily, and watching the effects of the baths. In addition to the water consumed before and between meals, the patient was instructed to drink eight ounces of it hot when he went into his bath, and another eight ounces as he was lying in the cooling-room afterwards. The bath consisted of complete immersion, with the exception of the head, in the mineral water that was easily kept at a temperature of between 103 and 104 Fahr. by allowing the hot water to flow in continuously; the time limit was from ten to fifteen minutes, and after the first eight minutes light friction was commenced over the entire body. Upon getting into the bath the patient found the warmth very agreeable, but when about seven minutes had elapsed, he experienced a sensation of fullness behind the sternum to which he did not attach any importance, and made no mention of the fact. The pain so increased during the rubbing that at the expiration of other three minutes the suffering was so great that he could hardly get out of the bath even with assistance, and had to sit down until sufficiently recovered before walking into the cooling-room, a feat that could only be accomplished by resting three or four times on the way. Here he lay down upon the cot, but the slight increase in pressure, consequent upon assuming the horizontal position, caused the pain to return, so that it was fully twenty minutes later before he could recline with his head and shoulders supported upon six or seven pillows. Next day the resident physician told him not to take any water before enter-

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ing the bath, and also accompanied him and noted the pulse from the moment of immersion; otherwise the conditions were the same as formerly. At the end of eight minutes the sensation of fullness began to arrive, and simultaneously the pulse rose from 82 to 115. He was immediately removed from the bath, but the exertion of being dried and walking not more than twenty feet induced such severe pain that the patient had to sit down for several minutes before he could attempt to reach the cooling-room, where the former experience with regard to inability to maintain the horizontal position was repeated. The patient was made to understand the gravity of the condition, but he was one of those men who are more or less attracted to medicine from the fact of having several friends in the profession and having been round about hospitals both for business and charitable purposes, so that he became as much interested in his own case as the resident physician and myself, and decided to continue the baths. It would be superfluous for me to give a detailed account of each bath; they were given every day for ten days, and every other day for fourteen days; the temperature was generally 102 Fahr., and was never allowed to go above 103 F.; the total time of immersion never being allowed to exceed ten minutes. Pain was always readily induced upon the slightest effort after emerging from the bath, but not to such an extent as with the higher temperature, and a similar result obtained with diminished severity until the end of the treatment, although the maximum temperature was reduced to 101 Fahr. During the attacks the patient found that deep inspirations materially aided in diminishing their duration and intensity. The benefit is probably due to the fact that by this means there is an increase in the negative intra-thoracic pressure so that the blood from all the veins, including that of the coronary sinus, flows more freely into the right auricle, and also from the right to the left side of the heart. Naturally this both relieves strain and improves the coronary circulation.

No pressure records were made during the paroxysms, but for some time before the treatment was commenced the systolic pressure was generally between 165 and 170. At the end of four weeks the patient's condition had materially improved, although this was probably the result of observing a careful dietary, exercise, and drinking the water to promote elimination as prescribed by the resident physician.

The effect of the warm mineral baths was to me both extremely interesting and instructive, because it was my first opportunity of personally observing the onset of anginal attacks under such conditions, although I had on many occasions advised patients to avoid high temperatures, and to make their baths of as short duration as possible, rather from dread of possible syncope than from expectation of breast pain. That immersion in warm water should be followed by vascular dilatation and faintness seemed perfectly natural, but the production of angina pain was more difficult to understand.

In my wards at the San Francisco Hospital Dr. Kretsinger, at my request, made a series of observations on the effects of hot baths on blood pressure. The pressure was taken before the bath, with the patient in a reclining position, and again after total immersion of the body and limbs in water at 105 Fahr. for fifteen minutes, and the different readings compared. In five out of six cases there was a slight rise of 5 mm. to 7 mm. in systolic pressure, only one remaining unchanged. In all of them the bath was followed by a marked fall in diastolic pressure, generally to the extent of twenty-five or thirty mm. This of course means a great increase of pulse pressure or force of the cardiac systole, also of the heart load. One case was a man over 70 years of age suffering from well-marked arterio-sclerosis, but who was not subject to anginal attacks. Before the bath his systolic pressure was 160 mm. and his diastolic 90 mm.; at the end of fifteen minutes' immersion in the hot water systolic pressure remained unchanged, but the diastolic had dropped to 70 mm., so that the pulse pressure was increased from 70 mm. to 90 mm.

If the general assumption be correct that the *normal* heart load corresponds to fifty per cent. of the *diastolic pressure*, then this patient had an overload of twenty-seven per cent. before the bath, which was increased to seventy-eight per cent. of the diastolic pressure after fifteen minutes' immersion. As baths at this temperature are associated with marked acceleration of the pulse rate it is evident that the work of the heart must have been materially increased. The case observed in my ward were few in number, but their object was to note *possible* therapeutic effects or accidents against which precautions should be taken rather than to make statistics; hence even one was sufficient to establish the necessity for observing the influence of the baths not only on the systolic pressure, but also upon the diastolic pressure, pulse pressure and heart load at the beginning of a course of hydrotherapy.

Otfried Mueller, in 1902, published his observations on "The Physiological Action of Baths." The following is a summary of his conclusions: "(1) Baths with a temperature below the indifferent zone (33-35 degrees C.; 91.4-95 F.), produce an increased blood pressure, lasting throughout the bath, with a decrease in the pulse rate. (2) Baths with the water at a temperature above the indifferent zone to approximately 40 degrees C. (104 F.), produce, after a short initial rise, a lowering of the blood pressure to or below the normal; this lowering is then followed by a second increase in the pressure; below 37 C. (98.6 F.), in this group of baths the pulse rate is lowered, above this point it is increased. (3) Baths over 40 C. (104 F.), produce an increase in pressure lasting throughout the entire bath, with an increase of the pulse rate." (Forchheimer, "Therapeusis of Internal Diseases," vol. 3, page 618.)

Briefly stated, this patient's baths were given in the following manner: The temperature of the water upon entering the bath was 102 F., and when he was completely immersed it was rapidly raised to 104 F. by the addition of water that flowed in copiously at a temperature of 145 degrees. On the first occasion he remained for fifteen minutes, but subsequently the temperature was maintained as nearly as possible at 102 F., never being permitted to rise above 103 F., and the time was shortened to ten minutes. The case would therefore fall into the second of Mueller's groups, in which there is a short initial rise of pressure succeeded by a fall, and then a second increase in the pressure accompanied by an increase in the pulse rate. This is at variance with the usual physiological experience that pulse rate is inversely as the pressure; that whenever vascular dilatation takes place there is an

acceleration of the pulse, and that when the vessels contract there is a slowing, as if it were a purposeful endeavor on the part of the heart by its own exertions to maintain an approximately constant pressure. It is impossible to say the extent to which the second rise in pressure is due to a reciprocal compensatory action between the splanchnic and peripheral circulations, because sometimes these dilate simultaneously as during digestion, at other times the one is opposed to the other, and it is perfectly possible that during a bath, where the stimulus is peripheral and does not demand any functional activity on the part of the abdominal viscera, there may be a contraction in the vessels of the splanchnic area in an endeavor to avoid the fall in pressure consequent upon dilatation of the peripheral vessels. On the other hand, as already mentioned, the augmentation of the heart's work resulting from the combination of pulse acceleration and increased heart load is sufficient to induce an anginal attack without the production of any marked rise in arterial systolic pressure. Since these are the symptoms that, according to Mueller, arise in the healthy person who is given such baths, it can be readily understood that in the arterio-sclerotic patient, particularly if the splanchnic vessels be involved, the pressure may be easily disturbed to such an extent as to strain the heart and produce the most acute suffering. In such a case as that just reported the patient should not be allowed to continue the baths in the hope that he will become habituated to them; on the contrary, either they should be discontinued or the temperature and time of immersion reduced until he is absolutely free from distress. One paroxysm predisposes to another, it does not protect against it; indeed it would seem that when once a by-path has been established in the cord through which viscero-sensory impulses are diffused to the nerves of ordinary sensation, each attack makes the transmission more easy.

This second case contains a warning as probably it is an example of a hot bath producing heart overload in an arterio-sclerotic patient, from the effects of which he never recovered. Unfortunately I am not able to give you pressure data, as the patient came under observation in 1906 shortly after the San Francisco disaster, in which many of us not only lost our apparatus, but had difficulty in replacing it. This gentleman was also 58 years of age, and consulted me on account of a typical radiating anginal pain. It is not necessary for the present purpose to give a detailed account of the case, but simply to state that under treatment he recovered so far that instead of being unable to walk one block without stopping on account of pain, he could walk more than a mile without resting, gained twenty pounds in weight, made a long pleasure tour through Canada and Alaska, as well as three round trips between San Francisco and New York, without suffering any inconvenience. Subsequently he came to me from some "Springs," where he had been spending a short holiday with friends who advised him to take a hot mineral bath for the purpose of breaking up a cold; while in the bath he experienced a sudden attack of his former cardiac oppression and pain. He never afterward regained his former condition of health; but became subject to attacks of cardiac asthma, from which he died several months later.

Most hydro-therapists have agreed that the changes in pressure depend upon the temperature of the water much more than upon any action of the salts in solution, yet there cannot be any doubt that these have some influence, although our knowledge on this point goes very little beyond the general statement that the salts, especially the chloride, by process of endosmosis, reach the upper layers of the cutis to which they attract water from the deeper tissues. This abstraction of water stimulates the terminations of the cutaneous nerves, and, reflexly, the cardiac and vaso-motor centres. There is no absorption of salts through the skin into the circulation. Much greater importance is attached to the presence of carbon dioxide. This has been worked out especially in relation to the Nauheim Baths, and Mueller has found that in the artificial Nauheim Baths, while the *pressure* depends more upon the temperature of the water than upon the carbon dioxide present, on the other hand, these two factors participate almost equally in the production of changes in the *pulse rate*. It must be remembered that Nauheim Baths are not in the same category as those taken by the gentlemen whose cases have been narrated; these are generally given at temperatures varying from 83° to 91° F., and consequently fall into Mueller's first group. At one time it was believed and taught that the carbon dioxide produced a prolonged dilatation of the peripheral vessels, and therefore a lowering of pressure and lightening of the heart's work. This, however, is erroneous, and it has been shown that in the cool Nauheim Bath there is a rise in pressure due to contraction of the peripheral vessels which is not compensated by the splanchnic vessels, although these dilate to a considerable extent; that the ventricular output is increased, and that there is a greater and more rapid flow of blood through the peripheral vessels producing a pink color of the skin. As the pulse rate is slowed the increased output must be due to a more complete systole diminishing the amount of residual blood usually remaining in the ventricle, for it must be remembered that normally the ventricle does not empty itself with each contraction but that, in such animals as the dog, with a pulse rate of 90, about one-third of the ventricular contents remains after each systole. The effect of the Nauheim Baths is supposed to be due to the fact that carbon dioxide, accumulated on the body surface, retards the conduction of heat from the body to the water, and thus prevents the rapid cooling that takes place in plain water. In the carbon dioxide bath the peripheral nerves receive the usual stimulation from the application of cold, but the body temperature being longer maintained the result is as if the patient had a cold and warm bath simultaneously.

It is evident that the Nauheim Bath by simultaneously contracting the peripheral vessels and increasing the cardiac output produces increased work for the heart, that the temperature and amount of carbon dioxide being capable of regulation, the amount of this work can be graduated to the heart's capabilities, and finally that the adaptability of cases to the treatment will depend on the responsive power of the myocardium, rather than on the nature of the lesion. For the same reason it may be expected that such cases of arterio-sclerosis, kidney

involvement, or high blood pressure as are deemed suitable to hydrotherapeutic measures will frequently do better in the saline baths at a temperature of 94 F. to 96 F., than in those containing carbon dioxide, and at either a higher or lower temperature.

In conclusion, may I be permitted to again emphasize the fact that warm baths may be dangerous to patients suffering from arterio-sclerosis, because the higher temperature tends to increase the heart load by causing a slight rise in the systolic pressure but a marked fall in the diastolic, which, together with the acceleration of the pulse rate may result in serious augmentation of the strain upon the heart muscle.

In giving baths, therefore, the attendant must note the diastolic as well as the systolic pressure, and figure out the heart load, and not content himself by observing that the systolic pressure is not very much increased.

Discussion.

Dr. H. D'Arcy Power: A subject like this presents so many aspects that it is very difficult to discuss it. So many factors occur in all cases of high blood pressure that it is difficult to seek out those that are responsible for the immediate condition or its secondary symptoms.

We have forms due to hypertension alone, in which arteriosclerotic changes have not yet occurred, and whose causation is to be sought in toxic or autotoxic irritation, to altered internal secretions, or possible direct cerebral stimulus. In others there is a distinct laying down of fibrous tissue that at all times occludes a certain portion of the peripheral vessels and produces conditions not so amenable to treatment.

When we consider the action of a remedy like hot water or stimulating baths, in every case it must be determined, if possible, which of these conditions is chiefly present, and act accordingly. More important, it seems to me, in all questions of high blood pressure, is not the immediate effect of certain measures, as hot baths or the use of the X-ray, but what the final result is. Let us assume that after several weeks of the bath treatment the patient has a reduced arterial pressure, we still must ask which of many factors has been responsible? He has probably been taken away from business cares and given rest. How much has that reduced the blood pressure and how much the bath? His bowels have been attended to and his kidneys kept flushed, and his diet radically changed.

I have been recently watching the use of thermal penetration in reducing blood pressure in a business man, who is away from his business worries and is on dietetic treatment. He has had a fall in his blood pressure, but I am not convinced on that account.

As to Dr. Kerr's two particular cases, they are very interesting, particularly the first case with the anginal symptoms. It occurs to me that the change in the pulse rate (85-115) may have been more responsible for the anginal attack than the change in pressure. I have experienced the presence of anginal pain when the pulse rate has reached a certain frequency, and I also know by personal experiment that deep inspirations are capable of checking the pain. Whether this is due in all cases to an alteration of intrathoracic pressure or the movement of gas in the bowel is often a question.

The whole subject is one of extreme interest. I know of nothing at the present time that is more important than the study of these high pressure cases and the factors that induce them, but it will need hundreds of just such careful studies as Dr. Kerr has given before we shall be able to obtain clear indications for therapy. I think it is a very dangerous thing to take any step in high blood pressure which will suddenly increase the heart rate or reduce the ventricular pressure; in all such cases we have to go very slowly in using therapeutic measures.

Dr. Kerr (closing discussion): I did not mean to discuss the therapeutic value of baths in the treatment of arteriosclerosis, that would require about a book. All I wanted to do was to call attention to the danger which exists in arteriosclerotics going to mineral springs. We all know that they take these baths without supervision, and trouble is bound to occur. As I mentioned, at the beginning of the feeling of oppression the pulse rate may rise from 85 to 115—a sudden jump. Another point I wanted to emphasize is the change in systolic pressure, there may be none, or it may be slight. In those other patients in my ward the systolic pressure never increased above 5 mm., but there was a big fall in the diastolic: 30 to 35, and in one case 40. This, taken with the acceleration of the pulse, means an immense increase in the heart load. Of course in the case of the old arteriosclerotic, the overload of about 75 after the bath and greatly increased pulse made a terrific amount of work for the heart to do.

The first thing noticed is that the indiscriminate use of baths in angina is to be avoided. In the next place we must not be guided by systolic pressure—the difference in diastolic pressure and pulse rate means a great deal more.

Cases like these explain to us why in many cases of arteriosclerosis we find attacks of angina pectoris coming on with very little increase of systolic pressure. You find on examination nothing abnormal in the systolic pressure, yet the patient is suffering considerably. In those cases you will generally find a low diastolic pressure which shows that the balance has been disturbed.

Dr. Saxton Pope: I have seen several cases of angina made worse by hot baths. I know of a gentleman having had angina pains lasting only two or three weeks. The blood pressure was 175, and he was addicted to hot baths. After taking a very hot bath one night—the temperature was probably 110—he went to bed with slight pain in the precordium. The next day he was found dead in bed, with his light going and his spectacles on his nose. The autopsy showed coronary thrombosis.